



<Original>Factors Affecting Fecundity of the
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(Neuroptera: Mantispidae)

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Factors Affecting Fecundity of the Mantispid, *Eumantispa harmandi* (Navás) (Neuroptera: Mantispidae)

Shin-ichiro HIRATA, and Minoru ISHII

(Entomological Laboratory, Graduate School of Agriculture and Biological Sciences, Osaka Prefecture University, Sakai, Osaka 599-8531, Japan)

Abstract

Field-collected females of *Eumantispa harmandi* (Navás) were reared under various feeding conditions at 25°C to investigate the relationship between fecundity and food consumption. They survived 14-49 days and laid 380-6,650 eggs in 1-6 egg batches containing 22-2,027 eggs each. The fecundity had a positive relationship to the food consumption, but was independent of the body size. The survival period had a negative relationship to the body size, and a positive one to the number of ovipositions. The results showed that fecundity of *E. harmandi* were determined by food consumption during the adult stage.

Introduction

Fecundity has been reported to increase with density or consumption of prey in arthropod predators such as mantis (Matsura and Morooka, 1983, Eisenberg *et al.*, 1981), carabid beetles (Baars and van Dijk 1984; Lenski 1984; Sota, 1985), coccinellid beetle (Dixon, 1959), predatory bugs (Mukerji and LeRoux, 1969; Evans, 1976; Wiedemann and O'Neil, 1990), spiders (Turnbull, 1962; Suzuki and Kiritani, 1974; Wise, 1975), and predatory mites (Chant, 1961; Sandness and McMurty, 1970). The food habit in the nymphal stage is similar to that in the adult stage in most of these predators in which the fecundity is known variable with prey input.

On the other hand, there has been little information about the fecundity of predators in which the larva and adult depend on the different kind of preys from each other. However, the fecundity was reported to be determined from the adult body size affected by the amount of larval feeding in the lacewing, *Chrysoperla carnea*, which has predatory larval and phytophagous adult periods (Zheng *et al.*, 1993). Furthermore, Kiritani (1959) reported that the weight of newly emerged adults had positive relations with the longevity and fecundity in a leather beetle, *Dermestes maculatus*, in which adults and larvae feed on animal materials, as well as females could not lay eggs without feeding.

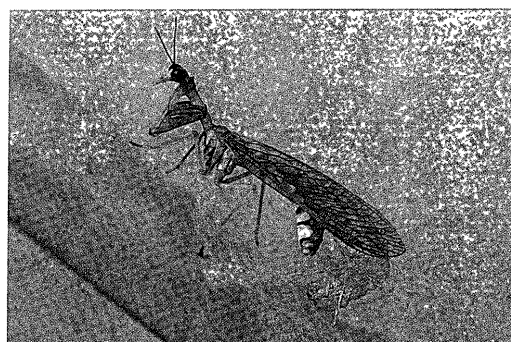


Fig. 1. A female adult of *Eumantispa harmandi*.

Recently, we made an investigation into the relationship between fecundity and consumption of prey in the yellow mantispid, *Eumantispa harmandi* (Navás) (Fig. 1). The first instar larvae of this species are found associated with various spiders (Hirata *et al.*, 1995). In most mantispids whose first instar associates with spiders, larvae develop in a single egg sac of spiders (Redborg, 1998), although adults are general predators (Boyden, 1984). Nawa (1903) reported in general terms that the number of eggs of *E. harmandi* was 5,600, but little is known about the reproduction of this species. In this study, adult females of *E. harmandi* were reared on different food conditions to determine the effect of food consumption on fecundity.

Materials and Methods

A total of 17 female adults of *E. harmandi*

were captured by using light traps at the 1,140 m point above sea level, of Mt. Wasamata, Kamikitayama Village in Nara Prefecture on August 5, 1992. These adults were individually put into 200-ml transparent plastic cups and reared under 25°C and 14L-10D in a laboratory. A sprayer was used to provide water for the adults every day.

The female adults were divided into 3 groups consisting of 5-6 individuals, and living adult moths of the subfamily Crambinae (Pyralidae) were given as food at 3 different intervals, one moth every two days (group 1), one moth every day (group 2), and four moths every day (group 3). The wet weight and prey consumption, and number of eggs laid by each female were recorded every one or two days. The wet weight was measured with an electric balance. The prey consumption was calculated as the balance between wet weight of preys given and those left. The experiment was continued until all females died.

Egg batches obtained were photographed to count the number of eggs, i.e., the batch size, afterward. In this paper, the total number of eggs laid by each female is regarded as the fecundity (Fig. 2). The body length and wing expanse of females were measured with a slide caliper after fixation from 70% ethanol after the end of the experiment. Statistical analyses were performed using SPSS version 6.1 (SPSS Inc., 1995).

Results

Fourteen of the 17 tested females laid eggs during the experimental period. The rate of females which laid eggs was lower in group 1, although the rate was not significantly different

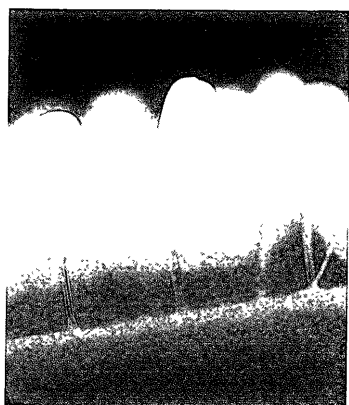


Fig. 2. Eggs of *Eumantispia harmandi*.

among groups (Table 1).

The mean body length and wing expanse of 14 females which laid eggs were 18.6 ± 2.4 and 42.0 ± 5.2 mm (mean \pm S.D.), respectively. Their fecundity ranged from 380 to 6,650, and a total of 40 egg batches were obtained: the range of batch sizes was 22 to 2,027. They lived 14-49 days after collection, and produced 1-6 egg batches.

The body weight of those females increased gradually with food consumption and decreased drastically after oviposition, so that it fluctuated greatly through the experimental period (Fig. 3). Since the body weight after oviposition reached to the minimal level in most females, it may represent the basic body size. In other words,

Table 1. Numbers of *Eumantispia harmandi* females which laid eggs and did no eggs, under three different feeding conditions

Feeding conditions	No. of females oviposited	No. of females not oviposited	P ²⁾
group1 (1/2) ¹⁾	3	3	—
group2 (1/1)	6	0	0.09
group3 (4/1)	5	0	0.12

1) 1/2 Given 1 prey every 2 days, 1/1 1 prey every day, 4/1 4 prey every day

2) vs group 1 by Fisher's exact probability test

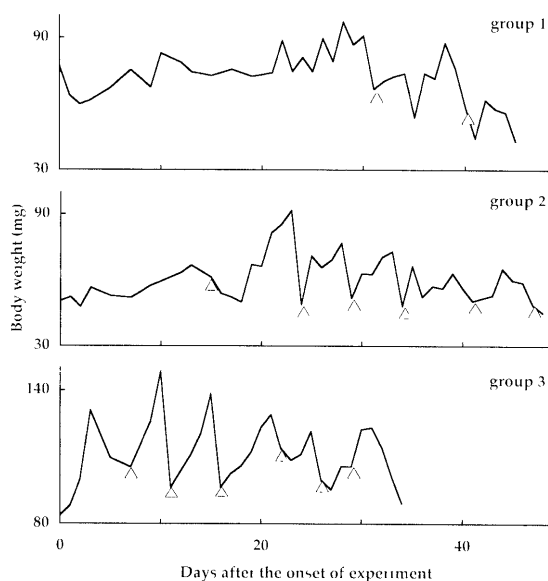


Fig. 3. Typical change in body weight in *Eumantispia harmandi* females from groups 1, 2 and 3 during the experimental period. Triangles show body weights just after ovipositions.

most of the gain in body weight by food consumption may be applied to the egg production.

By simple correlation analysis fecundity

Table 2. Correlations among several parameters obtained from the rearing experiment of *Eumantispa harmandi* females

Parameter 1	Parameter 2	r	t	P	df
Fecundity	Total food consumption during the experimental period	0.854	5.679	0.0001	12
	Body length	0.068	0.234	0.8186	12
No of oviposition	Total food consumption during the experimental period	0.654	2.994	0.0112	12
	Body length	-0.224	-0.796	0.4413	12
	Survival period	0.535	2.193	0.0487	12
Batch size	Food consumption between ovipositions	0.654	4.234	0.0003	24
Survival period	Fecundity	0.238	0.848	0.4133	12
	Body length	-0.601	-2.605	0.0230	12

increased significantly with total food consumption during the experimental period (Table 2, Fig. 4a), but not significantly with the body length (Table 2).

Furthermore, by multiple correlation analysis we obtained the following equation of total food consumption (x_1 : mg) and body length (x_2 : mm), to fecundity (y):

$$y = 231.39 + 6.25x_1 - 43.08x_2 \quad (R^2 = 0.732)$$

where R shows a multiple correlation coefficient. By analysis of variance, the coefficient of total food consumption (x_1) was significant at the 99% level (F-test), while that of body length (x_2) was not. This means that the body length is not a necessary factor in

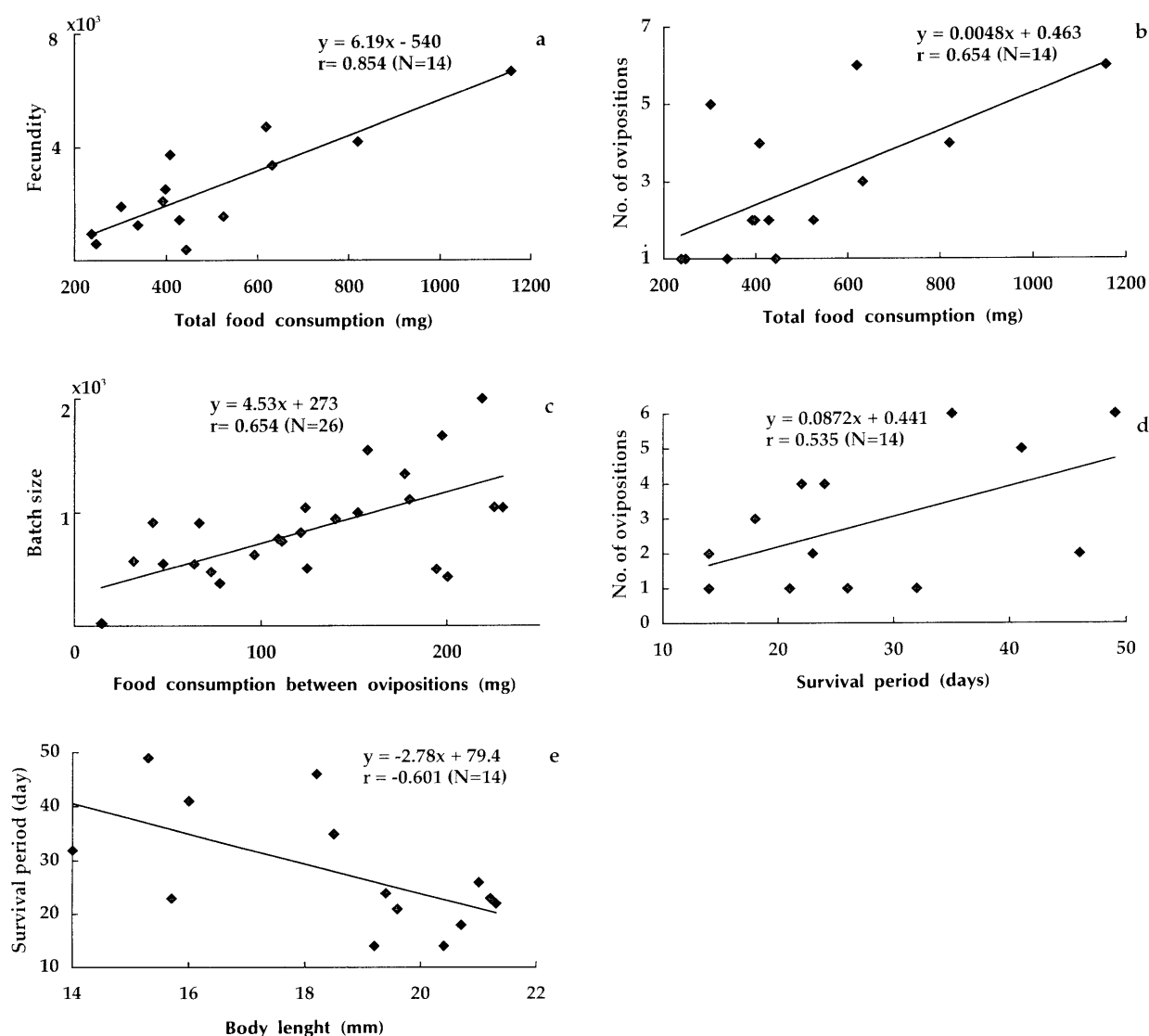


Fig. 4. Correlations among several factors affecting fecundity of female *Eumantispa harmandi* reared in the laboratory.

estimating the fecundity. Thus, these results suggest that not the adult size but the food consumption would strongly affect the female fecundity through the body-weight gain in *E. harmandi*.

The number of ovipositions increased significantly with the total food consumption (Table 2, Fig. 4b) and the batch size increased significantly with the total consumption between ovipositions (Table 2, Fig. 4c). Since fecundity is determined by both the number of ovipositions and batch size, the results again show that a primary factor of fecundity is the food consumption in *E. harmandi*.

The survival period, i.e. the period from the onset of the experiment to death, had a positive relation to the number of ovipositions (Table 2, Fig. 4d). It is interesting that it had a negative relationship to the body length (Table 2, Fig. 4e). This suggests that even smaller females of *E. harmandi* obtained the same fecundity as larger ones by surviving longer in a restricted food condition.

Discussion

It has been reported by many authors that the fecundity increases with food consumption in predatory arthropods including insects (Dixon, 1959; Chant, 1961; Sandness and McMurty, 1970; Suzuki and Kiritani, 1974; Evans, 1976). For instance, Matsuura and Morooka (1983) showed a positive correlation between adult prey consumption and fecundity in the praying mantis, *Tenodera angustipennis*, and pointed out the importance of prey density during the adult stage.

This study shows that the fecundity of *E. harmandi* is affected not by body size but by adult food consumption. In this species, because female adults lay eggs in several batches, the food consumption does not directly increase the fecundity, but affects it through an increase in the number of ovipositions and batch size. A positive correlation of food consumption between ovipositions and batch size suggests that the increase of fecundity is affected by not only daily food consumption but also by duration of feeding.

It is interesting that smaller individuals survived longer in *E. harmandi* for this experimental food condition. Since the adult size

and survival period were shown not to affect the fecundity, they may be independent of fecundity in this mantispid. However, to confirm this hypothesis, it is necessary to elucidate the relationship between the adult size and survival rate in the field.

The fecundity of phytophagous insects is reported to be determined by the adult body size (Clifford and Boerger, 1974; Chua, 1992; Honek, 1993). By contrast, there is a positive correlation between fecundity and adult food consumption in predatory arthropods such as stinkbugs, spiders and praying mantis (Suzuki and Kiritani, 1974; Matsuura and Morooka, 1983). If the egg size is constant, the fecundity increases with the adult food consumption in these arthropods. Some predators, such as spider and mantis, are considered to be subject to the food limitation (Miyashita, 1968; Anderson, 1974; Wise, 1975; Eisenberg *et al.*, 1981; Matsuura and Nagai, 1983; Sota, 1985). The adult body size is known to be affected by the larval food consumption in such predators as spiders, praying mantis and chrysopids (Turnbull, 1962, 1965; Matsuura *et al.*, 1975; Zheng *et al.*, 1993). It would be advantageous in these arthropod predators that the fecundity is determined by the food consumption during adult stage.

The first instar larvae of *E. harmandi* associate with juvenile, subadult and adult spiders, before moving into egg sacs produced by the host spiders (Hirata *et al.*, 1995). They are considered to develop inside the egg sacs by consuming the spider eggs like other mantispine species (New, 1986; Redborg, 1998). Therefore, the size of the spider egg sac is one of the primary determinants of the adult body size in mantispids including *E. harmandi*. Since larvae of *E. harmandi* associate with various spiders of various families (Hirata *et al.*, 1995), the variation in adult body size, which was observed in the materials in this study, might reflect the size of the spider egg sac.

If the fecundity is determined only by the larval food consumption, the host searching behavior of first-instar larvae would be the most important to raise the fitness in the mantispid. However, it may be difficult for the first-instar larvae which are as small as about 0.7 mm in body length to find the proper host spider by

themselves. Thus, it may be reasonable that the fecundity of the female *E. harmandi* is primarily determined by the food consumption in the adult stage

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